PA - 2126

Investigation of the penetrating plasma on the occasion of a discharge in mercury vapors.

determined only by the amount of the wall flux of the ions and is independent of the amount of the negative potential.

ASSOCIATION: Physical Institute of the Academy of Science of the U.S.S.R., Kiev
PRESENTED BY:
SUBMITTED: 6.1956
AVAILABLE: Library of Congress.

Card 3/3

GABOVICH, M. D.

"Anomalous Scattering and Excitations of Plasma Oscillations and Plasma Resonance."

paper presented at Second All-Union Conference on Gaseous Electronics, Moscow, 2-6 Oct '58.

GABOVICH, M.D.[Gabovych, M.D.]; NEMETS, O.F.; FEDORUS, Z.P.

On the utilization of a high-current pulse discharge in proton sources [In Ukrainian with summary in English]. Ukr.fiz.zhur. 3 no.1:104-111 Ja-F '58. (MIRA 11:4)

1. Institut fiziki AN URSR.
(Protons) (Electric discharges through gases)

GABOVICH, M.D. [Habovych, M.D.]; P'YANKOV, G.N. [P'iankov, H.N.]

Critical effect of the geometric dimensions of a high-frequency proton source system on the current intensity of an ion beam. Ukr. fiz. zhur. 3 no.3:419-421 My-Je '58. (MIRA 11:10)

1. Institut fiziki AN USSR.
(Protons) (Ion beams)

AUTHOR: Gabovich, M. D. 57-28-4-31/39

TITLE: On the Rational Utilization of the Magnetic Field in High--Frequency Sources of Protons (O ratsional'nom ispol'zovanii magnitnogo polya v vysokochastotnykh istochnikakh protonov)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 4, pp 872--880 (USSR)

ABSTRACT: The influence of the magnetic field upon a high-frequency discharge is investigated here and in this connection some conclusions on the rational utilization of the magnetic field in high-frequency sources of protons for practical purposes are drawn. Of the three possible kinds of utilization of the magnetic field in high-frequency sources that of the so--called "transverse effect" of the magnetic field (references 1,3) is investigated. All facts given here refer to the frequencies of 40-50 megacycles. It is shown that during the influence of the transverse magnetic field upon a high--frequency discharge, which is excited by means of an inductive connection, this field does not only promote the introduction of the power into the domain of discharge, but also leads to a much more effective utilization of this

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APPROVED FOR RELEASE: 03/13/2001 CIA-RDP86-00513R000513920017-3"

On the Rational Utilization of the Magnetic Field in High-Frequency Sources of Protons 57 28-4-31/39

power. It is further shown that this relatively weak magnetic field at the same time brings about an anisotropy in the distribution of the density of the ionization current. The latter fact leads to the conclusions that the mutual position of the coil causing the discharge, of the magnetic field and of the axis from which the ions are drawn out could be more rational. This conclusion is confirmed by the experiments with an ion source. It is shown that the use of a heterogeneous end-magnetic-field is more expedient than the use of a homogeneous magnetic field. Some experimental data on the influence of the magnetic field upon the high-frequency discharge are given. - Yu.S. Alpat'yev and Z.P. Fedorus participated in the measurements. There are 8 figures, 2 tables, and 7 references, 2 of which are Soviet.

ASSOCIATION: Institut fiziki AN USSR, Kiyev (Kiyev, Institute for Physics, AS Ukrainian SSR)

SUBMITTED: December 14, 1956

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GABOVICH, M.D.

66702

24(2)120

SOV/109-4-8-22/35

AUTHORS: Granovskiy, V.L., Luk'yanov, S.Yu., Spivak, G.V. and Siretenko, I.G.

TITLE: Report on the Second All-Union Conference on Gas Electronics

PERIODICAL: Radiotekhnika i elektronika, 1959, Vol 4, Nr 8, pp 1339 - 1358 (USSR)

ABSTRACT: The conference was organised by the Ac.Sc.USSR, the Ministry of Higher Education and Moscow State University.

A.A. Timofayev - "Measurement of the Gas Density During the Dynamic Operation of a Discharge" (see p 1306 of the journal).A.V. Nedospasov - The Nature of a Striated Positive Column".

V.I. Parel' and Yu.M. Kagan - "The Theory of Probes for Arbitrary Pressures".

Yu.M. Kagan et al. - "The Positive Column of a Discharge in a Diffusion Regime".

M.V. Konyukov - "Influence of the Processes of the Annihilation of the Negative Ions on Their Concentration in the Column".

M.D. Gabovich and L.L. Pasechnik - "Anomalous Scattering, Excitation of Plasma Oscillations and Plasma Resonance"

Yu.L. Klimantovich - "Energy Lost by Charged Particles for the Excitation of the Oscillations in Plasma (the Langmuir paradox)" and "The Theory of Non-linear Plasma Oscillations".

Ye.G. Martinkov and I.G. Nekrashevich - "Dependence of the Temperature in the Near-electrode Region of a Pulse Discharge on the Material of the Electrodes".

N.A. Neratina and B.N. Klyarfel'd - "Formation of Light Spots on the Anode of a Gas Discharge (see p 1301 of the journal).

N.A. Matveyeva -"Distribution of Binary Mixtures of Inert Gases in a d.c. Discharge".

V.G. Stepanov and V.P. Zakharchenko - "Some Phenomena in Rarified Plasma".

V.G. Stepanov and V.S. Bazel' - "The Possibility of Obtaining Highly Concentrated Plasmas".

G.V. Smirnitskaya and E.M. Reykhrudel' - "Some Characteristics of the Discharge in an Ion Pump and in a Magnetic Ionisation Vacuum Gauge".

Ye.T. Kucherenko and O.K. Nazarenko - "Properties of a Discharge with Electron Oscillations in a Magnetic Field" (see p 1253 of the journal).

The paper by L.M. Biberman and B.A. Veklenko considered the approximate methods for determining the concentration of atoms at the radiation levels.

I.I. Sobel'man and L.A. Vaynshteyn read a paper on "A Non-stationary Theory of the Stark Broadening of the Spectral Lines in Plasma".

M.A. Mazing and S.L. Mandel'shtam - "The Broadening and the Shift of Spectral Lines in a Gas-discharge Plasma".

R. Lunt (England) - "The Kinetics of Electron Collisions Leading to the Excitation of the Molecular Hydrogen in a Hydrogen Discharge".

V.N. Kolesnikov et al. - "Some Properties of the Arc Discharge in an Atmosphere of Inert Gases".

A.A. Mak and M.P. Vanyukov - "Production of High Temperatures By Means of Spark Discharges".

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21(7) SOV/56-36-4-10/70

AUTHORS: Gabovich, M. D., Pasechnik, L. L.

TITLE: The Anomalous Scattering of Electrons and the Excitation of Plasma Oscillations (Anomal'noye rasseyaniye elektronov i vozbuzhdeniye plazmennykh kolebaniy)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 4, pp 1025-1033 (USSR)

ABSTRACT: In the introduction, several papers dealing with this subject are discussed (Refs 1-11). The object of the present paper was the investigation of interaction between the electron beam and a plasma formed independently. The experimental arrangement (Fig 1) consisted essentially of a glass tube and an attached piece containing a probe. By means of a liquid mercury cathode and a special anode system a plasma was produced along the tube in the mercury vapor, the density of which amounted to $1.10^9 - 1.5.10^{11}\,cm^{-3}$ (mercury vapor pressure $p \approx 1.10^{-3}$ torr). An oxide cathode served as electron source. First, the characteristic at various (small) currents I_e of the electron beam

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current on the grid voltage on the analyzer probe (8 curves for I_e values of 0.05 - 13 ma with an anode current of 0.5 a, E = 50v, 1 = 50 mm). Plasma concentration was $n = 1.6.10^{10}$. The conclusions drawn from the course of the curves and the phenomena of anomalous scattering are discussed (The phenomenon which was first observed by Langmuir (Ref 1), consists in principle in the fact that electrons which have penetrated the plasma partly have high velocities). Figure 3 shows the dependence of the relative quantity of anomalously fast electrons on the position of the probe (again for different I_e-values).

The problem of the limiting current is discussed and illustrated by a table for different types of cathodes and different anode currents and plasma densities I_{lim} and j_{lim}. The following chapter discusses excitation and extinguishing of plasma oscillations occurring as a results of interaction between the electron beam and the plasma. Figure 4 shows the spatial course of oscillation intensities at various I_e-values and constant

Card 2/4 I_a = 10 ma, E = 40v. Figure 5 shows oscillation intensity

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distribution at various I_a-values and constant I_e = 13.5 ma. Figure 6 shows the dependence of wave length and oscillation intensity on I_a and figure 7 finally shows the radial intensity distribution of oscillations in the electron beam penetrating the plasma for various I_a-values. In the following, the influence exercised by an external magnetic field oriented parallel to the electron beam is discussed in short. Figure 8 shows the dependence of the position of the oscillation zone and of the scattering zone on the wave length of the observed electromagnetic oscillations (l increases linearly with λ); figure 9 shows the dependence of the position of the scattering zone on λ at 2 electron energies, E = 41 and 28 v. l also grows linearly with λ, the curve for greater E is somewhat steeper. Figure 10 shows the same for λ-values corresponding to a certain plasma concentration. A discussion of the results obtained shows that the effects observed may be explained qualitatively by the fact that electrons are assumed to gather in clusters and that these clusters coherently interact with the plasma. The

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The Anomalous Scattering of Electrons and the Excitation of Plasma Oscillations

authors finally thank N. D. Morgulis for discussing results. There are 10 figures, 1 table, and 15 references, 4 of which are Soviet.

ASSOCIATION: Institut fiziki Akademii nauk Ukrainskoy SSR (Physics Institute of the Academy of Sciences, Ukrainskaya SSR)

SUBMITTED: October 10, 1958

Card 4/4

9.3150,24.2120

77847
SOV/57-30-3-13/15

AUTHORS: Gabovich, M. D., Bartnovskiy, O. A., Fedorus, Z. P.

TITLE: Sag of the Potential on the Axis of a Discharge at Electron Oscillation in a Magnetic Field

PERIODICAL: Zhurnal tekhnicheskoy fiziki, 1960, Vol 30, Nr 3, pp 345-350 (USSR)

ABSTRACT: Kistemaker and Sneider (Physica, 19, 950, 1953) showed experimentally that in a discharge with electron oscillations in magnetic field potential on the axis of discharge may be considerably smaller than potential of anode. In the present paper the authors investigate causes for such a potential sag and examine conditions favoring effect. Figure 1 shows the diagram of experimental setup and measuring circuitry. In addition to cathode K and anode A, there are two reflectors O_1 and O_2 at the potential of the cathode of negative with respect to it. The cathode was either of tantalum, indirectly heated by bombardment of electrons originating on F or a directly-heated tungsten cathode. The

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whole 35 mm length of the system was in an uniform longitudinal magnetic field H variable 0-4,000 oersted. The behavior of anode current I_a, probe current I_p (at -80 v with respect to anode) and noise intensity in probe curcuit I_n as functions of magnetic field are presented in Fig. 2. For $I_H = 1$, H $\gtrsim$ 500 oersted. U_a was 300 v with respect to the cathode. The authors prove irregularities of the I_a curve are unambiguously related to noise intensity. They explain these irregularities by formation of a fundamental discharge column caused by axial oscillations of primary electrons in the raising magnetic field. At a certain optimum value of I_H the field starts substantially preventing plasma electrons from reaching the anode and produces a potential "groove." Its radial electrical field, in turn, facilitates motion of electrons toward the anode which was hampered by the presence of

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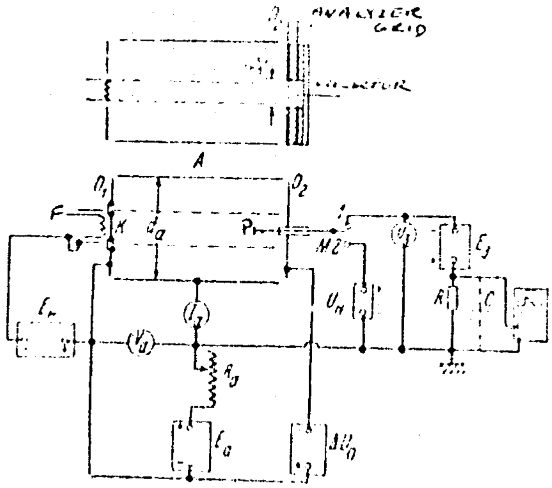

Card 3/11 Fig. 1.

Sag of the Potential on the Axis of a Discharge at Electron Oscillation in a Magnetic Field

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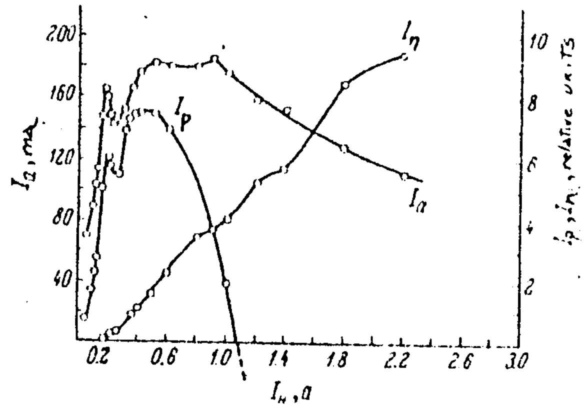

Card 4/11 Fig. 2.

Sag of the Potential on the Axis of a Discharge at Electron Oscillation in a Magnetic Field

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magnetic field. Further increase of H produces an unstable discharge, causing the mentioned irregularities and noises. The probe current changes sign because of an increasing number of primary electrons reaching it and a decrease of potential of paraxial plasma. Further increase of the magnetic field finally takes over and decreases the anode current until discharge is apparently completely halted. To measure potential inside the plasma the authors developed a special thermal probe consisting of a tungsten disc 1 mm diam and 0.05 mm thick on a tungsten wire inside an insulating quartz tube. By a relay M (see Fig. 1) probe P is raised to a potential U_H during a time interval τ_1. The electron current bombarding the probe can heat it sufficiently to produce an appreciable electron emission. During the second half of the cycle τ_2 probe is at potential U_p and, if the heating effect is now lower than previously, emission will decrease. Now, in the

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case of U_p being lower than plasma potential, decrease of emission is accompanied by a decrease of probe current while in $U_p > U$ plasma current changes sign and remains constant in time. The authors changed probe potential 20 times per second, observed current pattern on an oscilloscope, and registered plasma potential from those readings of the U_p voltmeter at which the decaying current pattern on the oscilloscope screen switched to the rectangular one. Results for measured potential U_a and plasma potential on discharge axis U_n are shown in Fig. 6 as a function of magnetization current I_H and diam of the anode. Analysis of results showed $\Delta U = U_a - U_n$ is a linear function of the square of the anode diam:

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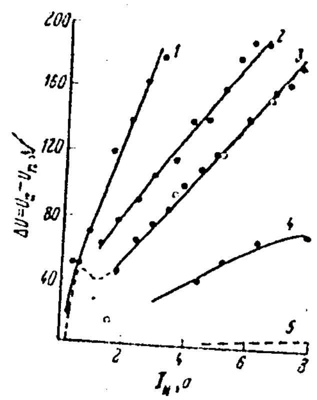

Fig. 6. (1) d_a = 4.0 cm (2) d_a = 3.4 cm (3) d_a = 2.7 cm (4) d_a = 1.8 cm (5) d_a = 1.0 cm

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The authors discovered that radial potential drop is almost completely located outside the axial plasma of diam equal to diam of the cathode. They note, however, all measurements mentioned above were done in the presence of a perturbation caused by the presence of the probe. They circumvent this objectionable situation by developing a special setup consisting of a grid across an ϕ = 8 mm opening on the reflector O_2 followed by another analyzer grid and a collector. Distribution of potentials is shown on the right in Fig. 8. The authors assumed there would be an appreciable ion current on the collector only when potential of analyzer grid U_c is equal or smaller than potential of plasma U_n. Using these values they constructed the curves in Fig. 8 for an anode 2.7 cm diam. Extrapolated potential values in the manner indicated in Fig. 8 then yielded points marked by hollow circles in Fig. 6. The agreement between the two methods is apparently very good.

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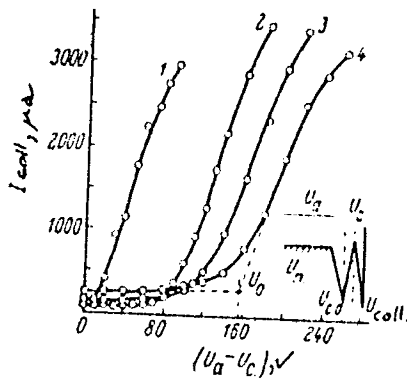

Fig. 8. (1) I_H = 1.5 a (2) I_H = 3.5 a (3) I_H = 5.0 a (4) I_H = 6.5 a

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The authors finally did some theoretical calculations starting from the equation of radial electron current density

$$j_- = -D \frac{dn_-}{dr} + \frac{De}{kT} n_- \frac{dU}{dr} \qquad (1)$$

and the continuity equation

$$\frac{dj_-}{dr} + \frac{j_-}{r} = \beta n_- . \qquad (2)$$

Assuming n_- to be constant, they obtained a theoretica[l] expression for ΔU in volts

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$$\Delta U(v) \approx 10^{-2} \cdot H(\text{oe})\, d_a^2. \quad (5)$$

which for H = 1,500 oersted and d_a = 4 cm yields Δ U $\approx$ 240 v versus the experimentally measured value 180 v. The authors note relationship U = f(H, d_a^2) as well as value Δ U are in fair agreement with the experiment. The strong radial fields up to 100 v/cm are connected to a decrease of electron diffusion towards the anode. There are 8 figures; and 6 references, 3 Soviet, 1 Dutch, 1 German, and 1 U.S. The U.S. reference is: D. Bohm. The Characteristics of Electrical Discharges in Magnetic Fields. N. Y. 1949.

ASSOCIATION: None given

SUBMITTED: April 18, 1959

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9.3150, 21.2100, 24.2120

77848
SOV/57-30-3-14/15

AUTHOR: Gabovich, M. D.

TITLE: Role of Multiple Processes in Proton Formation in Ion Sources

PERIODICAL: Zhurnal tekhnicheskoy fiziki, 1960, Vol 30, Nr 3, pp 354-358 (USSR)

ABSTRACT: At the present time it is possible to obtain ion beams with a large proton content from appropriately constructed ion sources. The proton production mechanism is, however, in most cases unexplained except that experimental data indicate direct (single) processes during electron-molecule collision cannot represent an effective mechanism of proton creation. The author assumes a large proton content is connected to multiple processes of electron collisions with heavy particles and considers some of the possibilities together with experimental data in favor of such a point of view. He investigates the following possibilities:

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Role of Multiple Processes in Proton Formation in Ion Sources

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a) $H_2 + e \rightarrow H_1 + H_1$, b) $H_1 + e \rightarrow H_1^+$.

a) $H_2 + e \rightarrow H_2^+$, b) $H_2^+ + e \rightarrow H_1^+ + H_1$.

a) $H_2 + e \rightarrow H_2^+$, b) $H_2^+ + e \rightarrow H_1 + H_1$, c) $H_1 + e \rightarrow H_1^+$.

The author assumes also: (1) gas pressure and degree of ionization are low, particle free paths are larger than size of the container, and gradients of particle concentrations are negligibly small; (2) recombination of atomic hydrogen occurs only on the walls and represents an effect of the first order; the number of recombined atoms is proportional to the product of the flow of atoms toward the walls and the coefficient of recombination. The ratios of the numbers of obtained protons and molecular ions are then given by:

for process 1 $$\frac{\nu_{1^+}}{\nu_{2^+}} = \frac{8hFn_0}{3v_a r}\int \ldots H_2$$

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for process 2 $$\frac{\nu_{1+}}{\nu_{2+}} = \frac{n_{H_2^+}}{n_{H_2}} \cdot \frac{\int_{diss\,H_2^+}}{\int_{ion\,H_2}}. \qquad (2)$$

for process 3 $$\frac{\nu_{1+}}{\nu_{2+}} = \frac{8RFn_e}{3v_{ar}} \cdot \frac{n_{H_2^+}}{n_{H_2}} \int_{diss} \qquad (3)$$

Here n_e, $n_{H_2^+}$, and n_{H2} are respective concentration of

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e^-, H_2^+, and H_2; v_2 is mean velocity of atoms. $\int_{\text{diss. } H_2}$ represents the integral

$$\int \sigma_{\text{diss } H_2} c f(c)\, dc,$$

with $\sigma_{\text{diss. } H_2}$ as electron collision dissociation cross-section of molecules, and f(c) as velocity distribution function for electrons. F represents ratio of integrals corresponding to atomic and molecular ionization. In low ionization, as in the plasma of a stationary hf ion source with moderate generator power, the dominant production mode is (1). The author computes the process using the $\sigma_{\text{diss. } H_2}$ value by Massey and Mohr. (Proc. Roy. Soc., A, 135, 358, 1932), assumes

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f(e) to be Maxwellian, and obtains

$$B = \frac{\beta}{(1-\beta)(1-0.3\beta)} \frac{760\,\Phi(kT_e)\,FV\,[\mathrm{cm}^3]}{v_0\,[\mathrm{cm/sec}]\,(S_1 r_1 + S_2 r_2)\,[\mathrm{cm}^2]}\, j_{+}\,[\mathrm{ma/cm}^2]. \qquad (7)$$

where β is given by

$$\beta = \frac{j_{+1}}{j_{+1} + j_{+2} + j_{+3}}$$

j_{+k} is current densities corresponding to ions H_1^+, H_2^+, H_3^+; V is volume of the source; S_1 is its glass surface; S_2 is surface of metallic parts; r_1 and r_2 are corresponding coefficients of recombination; $\Phi(kT_e)$ is certain tabulated functions slowly varying with kT_e in the interval under consideration (for $T_e = 5 \cdot 10^4 - 1 \cdot 10^5$ °K, $\Phi(kT_e)$ varies from 0.5-0.62). According

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to Eq. (7) B should be proportional to the total ion current density. To check the expression, the author established a 45 Mc/s discharge of variable intensity inside a spherical pyrex tube. Using two electrode probes (Al and Mo) and a mass analyzer described elsewhere (M. D. Gabovich. PTE, 2, 88, 1956), the author measured composition of the ion beam and obtained the curve in Fig. 1 which is indeed linear. Performing auxiliary experiments with and without a tungsten spiral inside the discharge tube, the author established the ratio r_2/r_1 is in the limits $40 < r_2/r_1 < 80$. Taking $r_1 = 1.6 \cdot 10^{-4}$ from the work of Poole (Proc. Roy. Soc., 163, 404, 1937) the author found r_2 to be significantly smaller than 1 so he could neglect the term $S_2 r_2$ in Eq. (7). Computing then theoretically he got a value for $B/J_+ = 0.44$. Comparing this value with the experimental value of 0.37, he concluded the assumption about the paramount importance of the process (1) was right.

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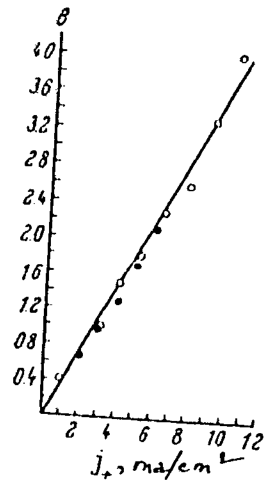

Card 7/9 Fig. 1.

The author further concluded to obtain a value of $\beta \approx 80\%$, which was reached in the pyrex tube experiment with $J_+ \approx 10$ ma/cm^2, one would need 1-10 a/cm^2 if the tube were metal because of strong recombination on walls. This agrees with experimental results of Gabovich and others (UFZ, 3, 104, 1958); although there, in view of a larger degree of ionization, competing processes could have played an important role. In the case of proton production by a metallic capillary arc, the proton content is limited by the small value of the effective radius of the chamber $R_{eff} \approx V/S$ in Eq. (7). Competing with the above electron collision processes in the proton production are collision processes between heavy particles. The widespread belief that the latter processes are characterized with a large cross-section are not experimentally verified in the electron-volt energy region. The author also notes precise mass-spectrometric results of Demirkhanov (M. Ardenne. Tabellen der Elektronenephysik, Jonenphysik u. Ubermikroskopie, (Tables of the Physics of

Role of Multiple Processes in Proton Formation in Ion Sources

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Electrons, Ions, and Ultra-Microscopes) Berlin II, 836, 1956) who showed that in a plasmatron, along with fast protons caused by process (1), one finds slow protons because of the disintegration of H_3^+. However, if the coefficient of recombination is smaller than 1, the slow protons could also be caused by atoms that, by the time they become ionized, lose most of dissociation energy in collision with the walls. There are 2 figures; and 16 references, 4 Soviet, 1 German, 5 U.K. and 6 U.S. The recent U.K. and U.S. references are: B. J. Wood, H. Wise. J. Chem. Phys., 29, 1416, 1958. L. A. Edelstein. Nature, 182, 932, 1958. E. V. Ivash. Phys. Rev., 112, 155, 1958. E. Bauer, Ta-You-Wu. Canad J. Res., 34, 1436, 1956. E. H. Kerner. Phys. Rev., 92, 1441, 1953.

ASSOCIATION: Institute of Physics AS UkrSR, Kiyev (Institut fiziki AN USSR, Kiyev)

SUBMITTED: March 8, 1957

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B006/B070

AUTHORS: Gabovich, M. D., Pasechnik, L. L., Yazeva, V. G.

TITLE: Detection of Ion Oscillations in a Plasma

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 5, pp. 1430-1433

TEXT: Ion oscillations with a limiting frequency of $f_0 = \sqrt{ne^2/\pi M}$ have been known for electron beams with compensated space charge, but they had not yet been found in the plasma of a gas discharge. It is shown in the present work that it is possible to make a direct determination of self-sustaining ion oscillations in the plasma of a gas discharge. The experimental apparatus consists of a discharge tube in which there is an arc discharge in mercury vapor; the charge concentration in the plasma can be varied by varying the discharge current. There are two probes in the plasma, one fixed and the other movable. The distance between them could be altered from 0 to 15 mm. The arrangement for the detection of ion oscillations is described in brief. Essentially, it consists of a preamplifier, a superheterodyne amplifier of the type ИП-12М (IP-12M), a special three stage

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Detection of Ion Oscillations in a Plasma

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narrow-band amplifier, and a tube voltmeter. The sensitivity of the amplifying arrangement can reach $\sim 2 \cdot 10^{-8}$ v. The results of measurement are shown in Fig. 2: With increasing discharge current I, the voltage U_{out} at the output of the amplifier system increases, passes through a maximum, and then falls steeply. The position and the height of the signal peaks in the $U_{out}(I)$ diagram depend on the frequency f of the amplifier. Fig. 2 shows the characteristics for f = 1.6, 2, and 2.4 Mc/sec. Fig. 3 shows the dependence of the resonance currents on the potential of the probes for 6 f-values between 1.6 and 2.6 Mc/sec. I_{res} increases linearly with U_{probe}, and the greater f the greater is the slope of this straight line. (I_{res} is the I-value corresponding to the peak of U_{out}). The following relation (2) holds for the frequency of the ion oscillations: $f = f_o/\sqrt{1+ne^2\lambda^2/\pi kT_e}$, where λ is the wavelength. With this, the charge density in the plasma is $n = f^2/(e^2/\pi M - e^2f^2\lambda^2/\pi kT_e)$; ($n_{exp} \approx 10^{10}$ cm^{-3}). It may be assumed that the probe selectively indicates oscillations with a wavelength that is

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approximately equal to the radius of the ion layer surrounding the probe. Since the radius of the ion layer surrounding the probe increases with increasing potential of the probe, n and I_{res} must increase not only with f but also with negative potential U_{probe} of the probe. This is actually found to be so experimentally. It is also found that $\lambda^2 < kT_e/Mf^2$. As a practical example (corresponding to the experimental conditions), one has $\lambda_{max} = 6.4 \cdot 10^{-2}$ cm with $T_e = 3.8 \cdot 10^4$ °K and $f = 2 \cdot 10^6$ cps. Such a thickness of the ion layer ($\sim \lambda_{max}$) fairly agrees with the experimental results. By extrapolating the curves shown in Fig. 3 for a zero potential of the probe, n_o and $I_{o\ res}$ may be obtained; and also here theory and experiment agree satisfactorily (Fig. 4). It has, thus, been possible to detect by these experiments the oscillations of ions and to verify formula (2) qualitatively. V. D. Rutgayzer and K. I. Kononenko are mentioned. There are 4 figures and 6 references: 1 Soviet, 4 US, and 1 Irish.

SUBMITTED: November 23, 1959

Card 3/3

9.2585
9.4220

21444
S/109/61/006/001/023/023
E140/E163

AUTHOR: Gabovich, M.D.

TITLE: On the mechanism of exciting electron plasma oscillations

PERIODICAL: Radiotekhnika i elektronika, Vol.6, No.1, 1961, pp. 178-179

TEXT: In this letter the author discusses the conflicting opinions concerning the significance of Merill and Webb's (Ref.1) fundamental experiments. The author expresses the opinion that only the klystron model of excitation of oscillations is capable of explaining all the known facts.
There are 23 references: 11 Soviet and 12 English.

ASSOCIATION: Institut fiziki, AN USSR
(Physics Institute, AS Ukr.SSR)

SUBMITTED: April 21, 1960

Card 1/1

GABOVICH, M.D.

27960
S/185/61/006/004/002/015
D274/D303

26.2331

AUTHORS: Gabovych, M.D. and Romanyuk, L.I.

TITLE: Plasma ejection by electrodeless pulse-discharge in a vacuum

PERIODICAL: Ukrayins'kyy fizychnyy zhurnal, v. 6, no. 4, 1961, 461-466

TEXT: Experiments are described with bursts of plasma in a narrow channel. Fig. 1 shows the experimental setup used. In glass tube 1 a discharge takes place at a pressure of $4 \cdot 10^{-2}$ mmHg in region 1, and of below $1 \cdot 10^{-4}$ mmHg in region 5. The current related to the plasma-bursts was measured by moving electrode 6. Oscillograms were taken of the voltage drop across resistor 3 (which is part of the same circuit as 6). Oscillograms are shown of the current in circuit 6 at various voltages of the capacitor battery. The same figures show a plot of the time-derivatives of the exciting field-strength H. Another figure shows the dependence of the electron

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Plasma ejection...

and ion streams on the voltage U of the electrode 6. From the oscillograms it follows that the potential of the plasma with respect to electrode 6 is a periodic function of time. It turned out that the electron andion pulses were shifted by a half-period. The reason for this could be the changing longitudinal electric polarization of the plasma. In the above experiments, the voltage of electrode 6 was given with respect ot plate 4, made of metal. Further experiments were carried out, in which the voltage was given with respect to reference electrode 3, made of glass. In this case, the maximum ion-stream density at the outflow from the channel was well above 100 amp/cm^2. The velocity of the plasma was estimated by the magnitude of the time-shift of the pulse fronts related to the displacements of electrode 6. The velocity was found to be approximately $8 \cdot 10^6$ cm/sec., corresponding to a proton energy of nearly 30 eV. The charge concentration was found to be approximately $1 \cdot 10^{14}$ cm^{-3}. There are 6 figures and 6 references: 5 Soviet-bloc and 1 non-Soviet-bloc.

ASSOCIATION: Instytut fizyky AN USSR, m. Kyyiv (Physics Insti-

Card 2/3

Plasma ejection...

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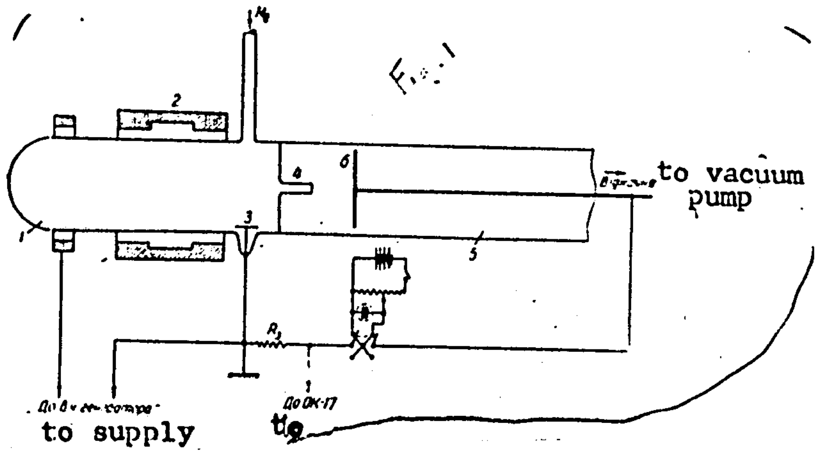
S/185/61/006/004/002/015
D274/D303

tute AS UkrSSR, Kiyev)

SUBMITTED: January 1, 1961



Card 3/3

Fig. 1

20668

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B104/B204

26.2321

AUTHORS: Gabovich, M. D., Pasechnik, L. L., and Romanyuk, L. I.

TITLE: The boundary of a penetrating plasma and plasma focusing

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 31, no. 1, 1961, 87-93

TEXT: The authors describe a probing method for determining the boundary of a penetrating plasma. The experimental arrangement shown in Fig. 1 consists of a pulsed ion source with electron oscillations in a magnetic field. The discharge current attains 40 a, the ion pulses have a rectangular shape, the pulse repetition frequency is 50 cps, and the magnetic field strength is about 300 oersteds. The discharges were produced in hydrogen at a pressure of $5 \cdot 10^{-3}$ mm Hg. The plasma coming from the source passes through an opening in an electrode (9), and reaches a lens consisting of two cylinders (10) and (11) (inner diameter of the cylinder: 120 mm; L = 120 mm; distance ΔL: 20 mm). Electrode (11) has a negative potential of U_0 = 50 kv relative to electrode (10). A beam catcher prevents secondary electron emission from electrode (11). Probes (7) and (8) could be shifted. The signal coming from the probes was amplified X

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20668

The boundary of a penetrating S/057/61/031/001/013/017 B104/B204

and fed into a peak generator. The output signal of this peak generator was conveyed to a recorder, whereby the spatial distribution of the probe current could be recorded. From the axial and radial distributionsof the plasma parameters near the opening, which are shown in Figs. 4 and 5, it follows that an increase of the negative potential of electrode (11) up to U_o = 30 kv produces no effect upon the distribution of the plasma parameters. At a greater distance from the opening, determination of the plasma parameters is more difficult. The authors confined themselves to determining the plasma boundary, and, for this purpose, they applied a potential of 100 v to the probe relative to electrodes (5) and (9); the probe current was automatically recorded. In this way, a plasma boundary could be clearly determined. This boundary is at a distance of about 10-15 mm from the opening and manifests itself in a change in the drop of the probe current. Up to approximately 10 mm, the probe current drops exponentially; at larger distances a greater drop occurs (Fig. 6). In this way, it is possible to determine the plasma boundaries for various conditions. As may be seen from a close study of the plasma boundaries, the shape and position of the plasma boundary change with a change in U_o, which is equal to a change in the focusing properties of the system.

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If the plasma boundaries are simulated with metal electrodes of corresponding configuration, it is possible, conditions being suitable, to construct the ion trajectories (Fig. 9). From this figure it may be seen that by increasing the potential and extending the plasma boundary, the ion current focused in the beam catcher may be increased. Fig. 10 graphically represents the experimental dependence of the ion current on the potential U_o. There are 12 figures, 1 table, and 7 references: 4 Soviet-bloc and 2 non-Soviet-bloc.

ASSOCIATION: Institut fiziki AN USSR Kiyev
(Institute of Physics AS UkrSSR, Kiyev)

SUBMITTED: June 1, 1960

X

24,2120 (1049,1482,1502)
10.8000
26.2321

20924
S/057/61/031/003/008/019
B125/B202

AUTHORS: Gabovich, M. D. and Romanyuk, L. I.

TITLE: Effect of a magnetic field on the shape of the boundary of a penetrating plasma and on plasma focusing

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 31, no. 3, 1961, 315-320

TEXT: The authors demonstrate that a magnetic field may considerably influence the shape of the boundary of a penetrating plasma. According to the configuration of the boundary concerned the magnetic field may improve or impair plasma focusing. The development of new methods of controlling the shape of the plasma boundary is of concern. The apparatus used for these experiments has been described already by M. D. Gabovich, L. L. Pasechnik, L. I. Romanyuk, (ZhTF, 31, 87, 1961). It is illustrated once again in Fig. 1. Like in earlier studies the authors used a pulsed ion source with a duration of pulses of 100 microseconds and with a frequency of 50 pulses/sec. In this case the plasma penetrated into the plasma lens consisting of electrodes 6 and 7 through a hole in electrode 4. The plasma boundary was determined by two probes 2 and 3. Fig. 2

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20924

shows the dependence of the amperage I_Φ measured in the beam catcher on the magnetic field strength produced by the solenoid. With an intensification of the magnetic field I_Φ decreases already with very weak magnetic fields. Fields with some dozens of oersteds are already sufficient for a considerable reduction of the ion current focused into the beam catcher. The configuration of the boundary of the penetrating plasma is changed as a result of its contraction and may impair the focusing properties of the system. Also a weak magnetic field may disturb plasma focusing, however, at least two cases exist where the magnetic field improves the focusing of the ions: 1) Focusing with lacking magnetic field under exclusive action of an electric field. 2) If the magnetic field in the discharge chamber of the source considerably penetrates into the region of the plasma to be studied. In the last chapter the author describes a ring-shaped plasma source. The following problem is dealt with: Let us replace the sole opening with its center on the axis of the source by several openings which lie on a concentric circle. Is the intensity of the plasma near the axis of the lens weakened and is the concentration thus distributed over the plasma surface? In what manner is the quality

20924

Effect of a magnetic field on the... S/057/61/031/003/008/019
B125/B202

of plasma focusing affected? For this purpose the central opening was replaced by 6 openings lying on a circle with a radius of 13mm; the ion source, however, remained the same. In the case of the holes circularly arranged the density of the ion current was considerably lower than with one central opening (in the cases studied here $j_p = 65$ ma/cm^2 and $j_p = 440$ ma/cm^2). In the case of circularly arranged holes more than 70 % of the total ion flux could be focused into the beam catcher. With the concentrically circularly arranged holes the configuration of the plasma boundary is much more concave than in the case of a single central opening. Also in this case the magnetic field impairs the focusing of the plasma since the plasma is contracted and a projection is formed on the concave boundary of the plasma. The authors conclude that the best results can be obtained by passing the plasma through openings which are at a certain distance from the axis of the source. In some cases such systems are less sensitive to the effect of magnetic fields. There are 12 figures and 3 Soviet-bloc references

ASSOCIATION: Institut fiziki AN USSR, Kiyev (Institute of Physics AS UkrSSR, Kiyev)

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23722
S/057/61/031/006/006/019
B116/B203

26.1410

AUTHORS: Gabovich, M. D. and Mitropan, I. M.

TITLE: Observation of hydromagnetic oscillations in the plasma of an electrode-less pulsed discharge

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 31, no. 6, 1961, 676-679

TEXT: The radial oscillations of a plasma connected with the annular current formed in an electrode-less pulsed discharge were investigated in various papers, especially by G. B. F. Niblett, T. S. Green (Ref. 3: Proc. Phys. Soc. 74, 737, 1959). Here, the results of some experiments are presented. The electrode-less pulsed discharge was excited in a quartz or glass tube of 65 mm diameter, surrounded by two parallel-connected copper coils W_1 and W_2 with one winding each (Fig. 1). A battery of 10-μf capacitors charged to 20 kv was discharged into the circuit consisting of the said coils, the lead wires, and the discharger. The inductance of the current circuit was 0.1 microhenry so that the current oscillation period was about 6 μsec. The gas was previously ionized by a high-frequency discharge. The coil K placed in the quartz tube served as a magnetic

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APPROVED FOR RELEASE: 03/13/2001 CIA-RDP86-00513R000513920017-3"

23722

probe, and permitted the field strength on the axis of the system to be measured. The Rogovskiy belts P_1 and P_2 inside glass tubes permitted an observation and measurement of the annular currents in the gas in two parts of the tube (on the wall and on the axis), as well as an estimation of radial shifts of the current ring. These belts could be replaced by one belt which measured the total annular current in the gas. Another belt served for measuring the current in the copper winding. The circuits of the magnetic probe and of the belts contained integrating RC elements. The latter were chosen so as to observe, on the oscilloscope screen, the amperages and magnetic fields, and not their derivatives. The resulting oscillograms show that the plasma formed in the discharge (discharge in hydrogen at a pressure P=0.12 mm Hg) influences the strength of the magnetic field considerably. At first, the magnetic field easily enters the plasma. An increasing phase shift occurs between the two above-mentioned quantities with transition from the second to the third half-cycle. At the beginning of the third half-cycle, the field on the plasma axis has a direction opposite to the outer field. In the first quarter of the third half-cycle, the strength of this phase-shifted field increases strongly. This may be assumed to be due to the formation of a current ring, its motion toward the center, and the pinch of the magnetic flux "frozen" in the plasma. In such a pinch of the magnetic flux, the formation of radial oscillations of the plasma connected with the current ring may be expected. This is confirmed by data obtained with belts P_1 and P_2. The oscillograms obtained with the outer belt P_1 show that the increase in strength of the magnetic field is preceded by the formation of a plasma ring of some dozen ka near the wall. The oscillograms recorded by P_1 and P_2 show a shift of the plasma ring formed on the wall toward the axis. The radial oscillations of the plasma are observed after deformation of the current ring. This is shown by the oscillation of currents and the fluctuations in strength of the magnetic field observed at the beginning of the increase of the "frozen" magnetic field; at that time, the plasma layer connected with the current ring is near the middle of the tube radius. After a few oscillations, the plasma ring may shift toward the tube center because of the weakening of the magnetic field. The plasma ring is shifted toward the tube center when the current in the copper windings approaches its maximum, whereupon the current ring decomposes, the conductivity of the plasma decreases, and the outer field

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Observation of hydromagnetic ...

enters the whole plasma. Here, a sudden change of the field (negative to positive) is observed. It is a characteristic feature that the oscillations of the plasma ring occur during the pinch of the magnetic field opposite to the outer field, i.e., of the field, the lines of which are connected with the inner currents in the plasma, and not with the current in the outer winding. It is shown that the observed period of oscillations coincides, as to the order of magnitude, with the period expected according to the approximation of Ref. 3. It is pointed out that in the case of a heavy gas of the same pressure, the oscillation period is larger, which is also confirmed by the oscillograms obtained (hydrogen was replaced by krypton). The increase of the negative field observed in the discharge in hydrogen and the oscillations of the plasma ring were not observed in the discharge in krypton, as had been expected. The present paper was read at the Vtoroye soveshchaniye po teoreticheskoy i prikladnoy magnitnoy gidrodinamike (Second Conference on Theoretical and Applied Magnetohydrodynamics) in Riga on June 30, 1960. There are 7 figures and 5 references: 4 Soviet-bloc and 1 non-Soviet-bloc.

Card 4/5

23722

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B116/B203

Observation of hydromagnetic ...

ASSOCIATION: Institut fiziki AN USSR Kiyev (Institute of Physics of the AS UkrSSR Kiyev)

SUBMITTED: July 25, 1960

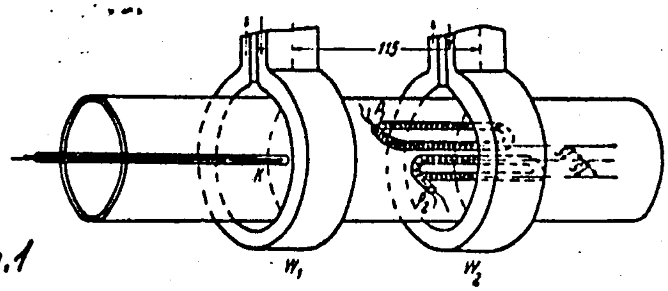

Fig. 1

Card 5/5

27166
S/057/61/031/009/006/019
B104/B102

26.2311

AUTHORS: Gabovich, M. D., Pasechnik, L. L., and Lozovaya, Ye. A.

TITLE: Discharge of a plasma with high concentration of charged particles into a vacuum

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 31, no. 9, 1961, 1049-1056

TEXT: The authors studied, by a probing method, the spatial distribution of the parameters of a hydrogen plasma with high concentration of charged particles (about 10^{15} cm^{-3}). The plasma was produced by a pulsed discharge, the amplitude of the discharge current being about 50 ka. The oscillation period was about 25 μsec, the battery of condensers had 90 μf capacity, and was charged to 3 kv. The most important parts of the experimental arrangement were the plasma source (discharge space with 3 electrodes) and the empty space beyond the hole in the lowest electrode (cf. Fig. 1), where one or two probes could be shifted. All measurements were made at a hydrogen pressure of $5.6 \cdot 10^{-2}$ mm Hg in the source, and about 10^{-5} mm Hg outside the source. In all cases the oscillograms of

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the probe current were recorded together with those of the discharge current. Some peculiarities turned up in the transition from ionic to electronic current; in particular, a strong modulation of the electronic current took place. Such a modulation was observed when the probe exhibited a small positive potential with respect to electrode 2 (Fig. 1). Further, it was remarkable that the ionic current peak agreed almost exactly in time with the discharge current peak, while the electronic current peak was considerably shifted against the discharge current. This is explained by the fact that the probe current depends not only on the plasma concentration but also on the potential in the probe space at the given instant. After determining the probe characteristics, the authors determined the distributions of concentrations of charged particles, of electron gas temperature, and of the space potential. Fig. 9 shows examples of radial distribution of the probe current for distances of the probe from electrode 2 of 5, 10, and 20 mm. Results reveal that the axial distribution of parameters is the same as in plasma with low concentration of charged particles. The temperature gradient is here lower than in plasma with low concentration of charged particles. In the

27166

Discharge of a plasma with high... S/057/61/031/009/006/019
B104/B102

anode cavity, the temperature of the electron gas (about 50,000°K) is lower than in the cathode cavity (130,000-70,000°K). There are 9 figures and 8 references: 6 Soviet and 1 non-Soviet. The reference to the English-language publication reads as follows: The Characteristics of electrical discharges in magnetic fields. Edited by A. Guthrie and R. K. Walkering, N. Y., 1949.

ASSOCIATION: Institut fiziki AN USSR Kiyev (Physics Institute, AS UkrSSR, Kiyev)

SUBMITTED: August 1, 1960

Fig. 1. Diagram of the experimental arrangement. Legend: 1,2, and 3 are electrodes; 4 is the outlet of the plasma source (3 mm diameter); 5 is the discharger; 7 and 8 are the probes; C_0 is the capacity for maintaining the probe potential; (A) is an amplifier, (B) an oscilloscope.

Fig. 9. Spatial distribution of the plasma parameters. Legend: (a)

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GABOVICH, M.D. [Habovych, M.D.]; YAZEVA, V.G. [IAzieva, V.H.]

Correlation of low-frequency and high-frequency oscillations induced in a plasma by an electron beam. Ukr. fiz. zhur. 7 no.9:1015-1020 S '62.
(MIRA 15:12)

1. Institut fiziki AN UkrSSR, Kiyev.
(Plasma oscillations) (Electron beams)

.?216

S/057/62/032/011/008/014
B104/B102

26 ...
26.2312 /7

AUTHORS: Gabovich, M. D., and Kirichenko, G. S.

TITLE: The oscillation of ions in the region of the potential minimum and the low frequency oscillations in a gas discharge

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 32, no. 11, 1962, 1376-1381

TEXT: The oscillation properties of a vacuum diode having very low cesium vapor pressure and those of a mercury vapor diode, are investigated using an experimental arrangement as shown in Fig. 1. The positive ions of cesium produced by thermal ionization move to and fro between the cathode and a point of reversal which depends on the anode potential. If the potential minimum ($eV_m \gg kT$) is deep, the motion of the ion is determined not by its thermal velocity but by the electric field. The frequency of oscillations is calculated for pressure so low that the space charge of the cesium ions does not affect the motion of the ions. Application of Langmuir's relations (Phys. Rev., 21, 419, 1923) to the dimensions of the potential well leads to the following formula for the frequency of
Card 1/4

The oscillation of ions in the ...

S/057/62/032/011/008/014
B104/B102

the flight ion oscillations:

$$f=\frac{\pi^{3/4}}{2^{1/4}}\frac{\eta_1^{1/2}}{\xi_- + \xi_+}\frac{m^{1/4}e^{1/2}}{M^{1/2}(kT)^{1/4}}j^{1/2}.$$

Here η_1, ξ_+ and ξ_- are dimensionless parameters tabulated by Langmuir, m is the electron mass, M the ion mass, and j the density of the electron current. The frequency is found to be proportional to $j^{1/2}$ (Fig. 2). The oscillations are independent of the parameters of the external current circuit, are sinusoidal, and have constant frequency and amplitude modulation. The excitation of the oscillations is explained as follows: In the region of the potential well an oscillating electric field exists which modulates the ion velocity and consequently the ion current. This causes the depth of the potential well to pulsate and the anode current to oscillate. If the cathode is incandescent, have to traverse a double layer the positive ions in the plasma of a gas discharge to reach it. This double layer lies near the cathode. Inside the double layer there exists a potential minimum, the depth and dimensions of which can be

Card 2/4

determined from the anode current and the saturation current of the cathode in the same way as for the vacuum diode provided that the positive space charge is negligible. The flight-oscillations of the positive ions that occur under these conditions are the main cause of low frequency oscillations appearing in discharges with incandescent cathodes. There are 6 figures.

ASSOCIATION: Institut fiziki AN USSR, Kiyev (Institute of Physics AS UkrSSR, Kiyev)

SUBMITTED: October 5, 1961

X

Fig. 1. Block scheme. Legend: (1) commutator of the filament current, (2) electronic commutator, (3) superheterodyne, (4) oscillograph, (5) ЭНО-1 (ENO-1) oscillograph, (6) broad band amplifier, (7) cathode follower, (8) ОК-17 (OK-17) oscillograph, (9) amplifier.

Fig. 2. Dependence of the frequency on $\sqrt{j}$ for different filament currents. Legend: (1) 13.0 a, (2) 12.2 a, (3) 12.0 a, (4) 11.25 a.

38858

S/056/62/042/006/010/047
B104/B102

26.2531
26.2312

17

AUTHORS: Gabovich, M. D., Kirichenko, G. S.

TITLE: The excitation of oscillations on the passage of a beam of slow ions through a plasma

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 6, 1962, 1478 - 1480

TEXT: A discharge was produced in cesium vapor ($\sim 10^{-3}$ mm Hg) between the cathode and the anode (Fig. 1). The plasma of this discharge penetrated the side branch with probes, $З_2$, $З_1$, and З. The probes $З_1$ and $З_2$ are placed at distances of 9 and 15 mm from the probe З. A positive potential relative to the plasma was applied to З. At high temperatures of З, cesium ions were produced by surface ionization. Owing to the potential difference these ions fell into the plasma as a straight line beam. In agreement with the theory, low frequency oscillations were excited on the passage of slow ions through the plasma. The low frequency oscillations made their appearance at those temperatures of З at which cesium ions were produced. The frequency of the oscillations lies in the region of the

Card 1/2

ACCESSION NR: AT4025320 S/0000/63/000/000/0283/0291

AUTHORS: Gabovich, M. D.; Kirichenko, G. S.; Koydan, V. S.

TITLE: Excitation of plasma oscillations by an ion beam, and the possibility of determining the electron temperature

SOURCE: Diagnostika plazmy* (Plasma diagnostics); sb. statey. Moscow, Gosatomizdat, 1963, 283-291

TOPIC TAGS: plasma oscillation, ion beam, plasma ion oscillation, plasma electron temperature, plasma interaction, drift, standing wave

ABSTRACT: Continuing their earlier investigations ("Zh. eksperim. i teor. fiz." v. 42, 1478, 1962; Ukr. fiz. zh., in press), the authors describe apparatus aimed at checking the influence of electron drift in a direction opposite to the ion beam on the stability of the oscillations produced when an ion beam passes through a plas-

ACCESSION NR: AT4025320

ma. The apparatus and its operation are briefly described. It is reported that, unlike the earlier experiments, oscillations with noticeable amplitude were excited also in the absence of drift current. The properties of these oscillations are described briefly. In the presence of backward drift, a new type of more intense oscillation with a rather narrow frequency spectrum was also observed. It is concluded that the backward electron drift leads to establishment of a standing wave, to a considerable increase in the oscillations, and to a narrowing down of the frequency range. The ion threshold energy at which the excitation of these oscillations terminates is proportional to the electron temperature. This is in qualitative agreement with the theory and gives grounds for assuming that a new method will be developed for determining electron temperature. It is proposed in the future to broaden the range of electron temperatures of the investigated plasmas and also to carry out a rigorous quantitative determination of the threshold energy. Orig. art. has: 7 figures.

Card 2/3

ACCESSION NR: AT4025320

ASSOCIATION: None

SUBMITTED: 19Oct63 DATE ACQ: 16Apr64 ENCL: 00

SUB CODE: ME NR REF SOV: 003 OTHER: 000

Card 3/3

GABOVICH, M.D.

AID Nr. 995-11 21 June

PLASMA ION SOURCES AND ION-BEAM FORMATION (USSR)

Gabovich, M. D. Pribory i tekhnika eksperimenta, no. 2, Mar-Apr 1963, 5-19. S/120/63/000/002/001/041

A detailed review of the state of research and development of 1) ion extraction from plasma ion sources and 2) primary formation of ion beams is given, based on 59 articles (27 Soviet) published up to October 1962. The conditions of three methods of ion extraction are described: 1) the emissive surface of the plasma is flat, within the ion source, and close to the outlet aperture; 2) the emissive surface is concave, within the ion source, and much larger than the cross section of the outlet channel carrying the focused ion beam; and 3) the plasma extends beyond the ion source and forms a well-developed emissive surface ahead of the focusing lens. Each type is subjected to a broad analysis and interpretation of its potentialities. [VG]

Card 1/1

S/185/63/008/001/008/024
D234/D308

AUTHORS: Gabovych, M. D., Lozova, O. O. and Romanyuk, L. I.

TITLE: Possibility of location of the boundary of penetrating plasma by a beam of charged particles

PERIODICAL: Ukrayins'kyy fizychnyy zhurnal, v. 8, no. 1, 1963, 57-59

TEXT: If a beam of electrons passing through plasma and falling on a fluorescent screen is displaced away from the ion source, the bright spot on the screen will also be displaced in the same direction until the beam reaches the plasma boundary, and then in the opposite direction owing to the reflection of the beam at the boundary. By varying the inclination of the beam one can determine the position and the shape of the boundary. The authors describe an experimental installation which they used for checking this method. Data agree well with those obtained by the probe method if the potential is not too high. The error at high potentials is explained by the fact that the boundary becomes convex, and use of

Possibility of location ... S/185/63/008/001/008/024
D234/D308

heavy negative ions instead of electrons is suggested in this case. There are 3 figures.

ASSOCIATION: Instytut fizyky AN URSR (Institute of Physics of the AS UkrSSR), Kiev

SUBMITTED: August 3, 1962

Card 2/2

S/109/63/008/003/022/027
D271/D308

AUTHORS: Gabovich, M. D., and Kirichenko, G. S.

TITLE: Microwave generation by electrons oscillating in the potential well formed by positive space charge

PERIODICAL: Radiotekhnika i elektronika, v. 8, no. 3, 1963, 520-522

TEXT: A microwave generator is discussed, which consists of a diode with an ion current limited by space charge; the frequency does not depend on the external circuit but depends only on the collector potential. In a hot-cathode diode with cesium vapor, conditions can be created in which a potential well is formed near the cathode, and cesium ions oscillate in this well. The frequency of oscillations depends on emitter temperature, electrode spacing, potential difference, and the mass of oscillating ions. Frequency-voltage dependence is shown in a graph.

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A diode of this type can be used for microwave generation if the collector is made negative and cesium ions from the cathode are attracted towards it. Owing to the positive space charge limiting the current, a potential well is formed in which electrons may oscillate. The frequency is calculated as in the case of ion oscillation, except that electron mass is substituted for ion mass. The temperature of the emitter must be such as to produce both ions and electrons. In an experimental diode with indirectly heated tantalum emitter and cesium vapor, oscillations were detected in the range of 150 - 1000 Mc/s in a narrow temperature range around 1900°K. Frequency was found to be in good agreement with the analytical value. Wide frequency variations are possible. There is 1 figure.

SUBMITTED: August 13, 1962

GABOVICH, M.D.

L 18247-63 EWT(1)/EWG(k)/BDS/EED(b)-2/ES(w)-2 AFFTC/ASD/ESD-3/AFWL/ IJP(C)/SSD Pz-4/Pab-4/Pi-4/Po-4 AT 82

ACCESSION NR: AP3002115 S/0185/63/008/006/0624/0627 81

AUTHOR: Gabovych, M. D., Kyryr'chenko, G. S.

TITLE: Role of the velocity of ions during excitation of plasma oscilations by an ion beam.

SOURCE: Ukrains'kyy fizychnyy zhurnal, v. 8, no. 6, 1963, 624-627

TOPIC TAGS: plasma oscillation, ion beam transmission, ion beam-plasma interaction, stability, ion beam stability, plasma noise level, plasma excitation.

ABSTRACT: The purpose of this investigation was to verify the theory of stability of a slow ion beam when the ion energy increases. Theory predicts the criterion for stability as

$$\frac{V^2}{C_e^2} > \frac{\omega^2_{+\text{пл}}}{\omega_e^2}\left\{1+\left(\frac{\omega_{+n}}{\omega_{+\text{пл}}}\right)^{2/3}\right\}^3,$$

where V is the velocity of the beam ions, C_e the thermal speed of the electron s,

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ACCESSION NR: AP3002115

An experimental setup was devised by which it was possible to control the ion energy. Oscillations were measured by means of a probe up to a frequency of 4.35 Mcs at various values of delta V, the difference of potential between the emitter and the anode. At delta V value less than 3.5 Volt ions can not reach the probe, and only a noise was registered. At delta V between 4.5 and 13.5 Volt the ion beam excited plasma, so that definite oscillation peaks were observed on the spectrum. As the beam energy increased the oscillation amplitude decreased, and at a voltage exceeding 13.5 Volt it was impossible to observe oscillations because of the noise background. The oscillation amplitude and frequency are shown on fig. 3 of enclosure 01 as functions of ion energy E. The E values were calculated from delta V, the space potential and the contact potential difference between the probe which is coated with a Cs film and the emitter which has no such coating. The measured temperature T sub e reached about 20,000 K. The concentration of beam ions and plasma ions was about equal. The ion energy E was then at its highest value of about 6kT sub e. And when this value was exceeded the system became stable. The experiments substantiated the theory. The orig. art. has: 1 formula, and 3 figures.

Card 2/4 2 Physics Institute of UKR SSR. ACAD. of Sci.

L 64003-65 EWT(1)/EPF(n)-2/EWG(m)/EPA(w)-2 IJP(c) AT

AM5011014 BOOK EXPLOITATION UR/

33
B+1

Gabovich, Mark Davidovich

21

Plasma ion sources (Plazmennyye istochniki ionov), Kiev, Naukova dumka, 1964, 220 p. illus., biblio. (At head of title: Akademiya nauk Ukrainskoy SSR. Institut fiziki) 2,800 copies printed.

TOPIC TAGS: plasma, ion, plasma oscillation, ionized plasma, plasma source, ion source, hydrogen ion, ion beam, gas discharge

PURPOSE AND COVERAGE: This book is a survey of literature on gas discharge ion sources. Different types of plasma ion sources are examined: sources of atomic and molecular hydrogen ions and multiply charged ions, electrons and other particles. This study is also concerned with ion extraction and the primary shaping of ion beams. The yield of quasi-neutral ion flows in a vacuum and the role ofoscillation properties of plasma are also considered. The book is intended for scientific, engineering, and technical personnel and students.

TABLE OF CONTENTS (abridged):

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L 64003-65
AM5011014

SUB CODE: NP, ME SUBMITTED: 14Oct64 NO REF SOV: 142

OTHER: 274

Card 2/2

ACCESSION NR: AP4020578 S/0057/64/034/003/0488/C495

AUTHOR: Gabovich, M.D.; Romanyuk, L.I.; Lozovaya, Ye.A.

TITLE: Escape of plasma from an oscillating electron source into vacuum in the presence of a magnetic field

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.3, 1964, 488-495

TOPIC TAGS: plasma, plasma source, oscillating electron plasma source, plasma in magnetic field, probe measurements, thermal probes, plasma escape

ABSTRACT: The escape of a helium plasma from an oscillating electron source into vacuum was investigated experimentally in the presence of a magnetic field. The source employed a 6-mm diameter indirectly heating cathode on the axis of a 3-cm diameter cylindrical anode. The reflecting electrode was located 6 cm from the cathode, was kept at cathode potential, and had a 3-mm diameter opening for plasma escape. The glass vacuum chamber was about 12 cm in diameter and 27 cm long. Gas pressures of 2×10^{-2} and 2×10^{-4} mm Hg were maintained in the source and the vacuum chamber respectively. Anode potentials from 150 to 200 V were employed with discharge currents from 1.0 to 1.5 A. The source and vacuum chamber were located in a

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ACC.NR: AP4020578

uniform longitudinal magnetic field of 1000 Oe or less. The escaping plasma was investigated with probes of various types. In spite of the strong magnetic field, the ion current in the escaping plasma was not confined to the axis of the chamber but extended several centimeters from the axis. The ion current was due mostly to ordered motion, the current due to chaotic motion being very small. Most of the ions had energies roughly equal to the cathode drop in the discharge. There was a small admixture of lower energy ions. The distribution of electrical potential in the escaping plasma was determined with the aid of two types of thermal probe. At a fixed distance from the source the potential, as a function of the radius, showed a minimum on the axis of the chamber and a maximum some millimeters off the axis. On the axis the potential (with respect to the cathode and reflector) was large and positive near the source and fell rapidly to zero within a few centimeters. At the axis of the chamber an insulated probe assumed a large negative potential of several tens of volts. This potential increased in absolute value (became more negative) as the distance from the source was increased. When the probe was moved off the axis, the potential first fell rapidly to zero and then became positive. This behavior is interpreted as indicating the presence of a narrow beam of fast electrons produced by interaction of the electron current with the plasma within the source. Orig.art. has: 3 formulas and 7 figures.

ACCESSION NR: AP4040299 S/0057/64/034/006/0993/0997

AUTHOR: Gabovich, M.D.; Mitropan, I.M.

TITLE: Interaction of plasma streams moving in opposite directions along the axis of an induction pinch

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.6, 1964, 993-997

TOPIC TAGS: plasma, plasma containment, plasma stability, hydrogen plasma

ABSTRACT: The behavior of an induction pinch in a hydrogen plasma was investigated. The pinch was produced in a 6.4-cm-diameter glass tube by discharge of a 10-microfarad capacitor bank, charged to about 25 kV, through two copper loops encircling the tube and located 8.4 cm apart. The period of this system was somewhat greater than 6 microsec. The magnetic field at the axis of the tube was measured with a movable probe. When the hydrogen pressure was 0.1 mm Hg, the phenomena observed were the same as previously described by the present authors (ZhTF 32,1371,1962). At a pressure of 0.06 mm Hg, the oscillogram from the magnetic probe was the same as before, when the probe was located beneath one of the copper loops, but it altered as the probe was moved toward the central plane between the two loops. In this

ACCESSION NR: AP4040299

central region the magnetic field showed two maxima and fell to zero between them. This behavior is ascribed to an instability of the type discussed by W.E.Nixon, W. F.Cummings, F.H.Coensgen, and A.E.Sherman (Phys.Rev.119,1457,1960) due to the intermingling of two streams of plasma flowing in opposite directions toward the central plane from the regions of high magnetic field beneath the loops. The experiment was repeated with a constriction 1 cm in diameter and 3.5 cm long in the discharge tube and a specially constructed differential flux meter entirely outside the tube. Similar results were obtained. When one end of the constriction was closed with a glass stopper, preventing flow of plasma toward the central plane from one direction, the diamagnetic effect disappeared. Orig.art.has: 5 figures.

ASSOCIATION: none

SUBMITTED: 25Jun63 ATD PRESS: 3084 ENCL: 00

SUB CODE: ME, EM NR REF SOV: 002 OTHER: 004

Card 2/2

L 14480-65 EWT(1)/EWG(k)/EPA(sp)-2/EPA(w)-2/EEC(t)/T/EEC(b)-2/EWA(m)-2 Pz-6/ Po-4/Pab-10/Pi-4 IJP(c)/AFWL/SSD(c)/AEDC(b)/SSD/ASD(a)-5/BSD/ASD(f)-2/AS(mp)-2/ ASD(p)-3/AFETR/RAEM(a)/ESD(gs)/ESD(t) AT

ACCESSION NR: AP4047932 S/0056/64/047/004/1594/1595

AUTHOR: Gabovich, M. D.; Kirichenko, G. S.

B

TITLE: The threshold energy of ions in two-beam ionic instability

SOURCE: Zhurnal eksperimental'noy teoreticheskoy fiziki, v. 47, no. 4, 1964, 1594-1595

TOPIC TAGS: plasma, plasma instability, plasma oscillation, ion beam, electron temperature, plasma diagnostics

ABSTRACT: It is pointed out that relative motion of an ion beam and plasma or plasma streams can be accompanied by two-beam ionic instability. Oscillations can be excited in passage through the plasma. The present article describes experiments performed in order to determine the threshold energy of ions in two-beam instability. Ion beams with currents on the order of 1 mamp were passed through plasma formed in different gases, and oscillations excited by the beam at different electron temperatures were observed. It was established that the dependence of the amplitude of the oscillations on the ener-

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L 11140-65
ACCESSION NR: AP4047932

gy of the ions can be represented by a curve which contains a maximum. It was found that in accordance with theoretical predictions, the threshold energy of ions determined from the maxima as a function of the temperature of the ions is proportional to the electron temperature. The frequency of oscillations was determined to be approximately proportional to the velocity of the ions. It is pointed out that the experiments indicate the possibility of using two-beam ionic instability for thermalization of powerful ion beams in plasma with high electron temperature and for plasma diagnostics. Orig. art. has: 1 figure.

ASSOCIATION: none

SUBMITTED: 02Jul64 ENCL: 00 SUB CODE: NP, ME

NO REF SOV: 005 OTHER: 001 ATD PRESS: 3136

Card 2/2

L 27599-65 EWT(1)/EPA(sp)-2/EPF(c)/EPA(w)-2/EEC(t)/T/EWA(m)-2 Pz-6/Po-4/Pab-10/ Pr-4/Pi-4 IJP(c) WW/AT

ACCESSION NR: AP5003241 S/0057/65/035/001/0094/0100

AUTHOR: Gabovich, M.D./ Romanyuk, L.I./ Lozovaya, Ye.A.

72
46
B

TITLE: Formation of a quasineutral beam of accelerated ions in the plasma issuing from an ion source

SOURCE: Zhurnal tekhnicheskoy fiziki, v.35, no.1, 1965, 94-100

TOPIC TAGS: plasma, ion beam, ion source, ion acceleration

ABSTRACT: This paper reports a continuation of previous work of the authors (ZhTF 34,488,1964) concerning the reflex discharge ion source. The apparatus is similar to that described in the earlier paper, with such modifications as were required for the particular experiments performed. The apparatus was operated under a variety of conditions, the current-voltage characteristics were measured, and particular attention was given to the potential gradient in the plasma beam issuing from the source. The principal conclusion is that the following conditions are requisite for obtaining ions with energies corresponding to the cathode drop: the issuing plasma must contain an intense beam of primary electrons with appropriate velocity distribution; the plasma must issue from the chamber into a region of suf-

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ACCESSION NR: AP5003241

ficiently high vacuum; there must be not positively charged electrode outside the discharge chamber that could remove electrons from the issuing plasma. Orig.art. has: 6 figures.

ASSOCIATION: Institut fiziki AN UkrSSR, Kiev (Institute of Physics, AN UkrSSR)

SUBMITTED: 24Feb64 ENCL: 00 SUB CODE: ME,NP

NR REF SOV: 005 OTHER: 003

Card 2/2

L 41606-66 EWT(l) IJP(c) AT

ACC NR: AP6018796 SOURCE CODE: UR/0056/66/050/005/1183/1186

AUTHOR: Gabovich, M. D.; Kirichenko, G. S.

ORG: Institute of Physics, Academy of Sciences, Ukrainian SSR (Institut fiziki Akademii nauk Ukrainskoy SSR)

TITLE: Two-stream instability in a system of interacting ion beams

SOURCE: Zh eksper i teor fiz, v. 50, no. 5, 1966, 1183-1186

TOPIC TAGS: plasma instability, ion beam, plasma beam interaction, plasma electron temperature, plasma oscillation, Doppler effect

ABSTRACT: This is a continuation of earlier work by the authors (ZhETF v. 47, 1594, 1964 and elsewhere) dealing with the interaction of an ion beam with a plasma. These investigations have verified the basic theory of two-stream ion instability and have demonstrated the possibility of thermalization of an intense ion beam in a plasma characterized by a high electron temperature. The present study is devoted to instability of interpenetrating potassium ion beams with energies up to 4 kev in a plasma formed by the ionization of a gas (krypton or neon) at a pressure 3×10^{-6} - 10^{-4} mm Hg by these fast ions. It is shown that two-stream ion instability can arise in such a system, which can be regarded as consisting of two ion beams moving in the same direction but with different velocities, if the energy difference in the beams is smaller than some threshold value. For example, for ion beams with energies of the order of several kev, with electron temperature of 1 ev, the threshold may be

L 41606-66

ACC NR: AP6018796

several hundred volts. The oscillations predicted by the theory were actually observed and their spectra determined and analyzed. The results show that the instability leads to an effective exchange of energy between the beams and that the energy exchange increases with increasing beam current. This points to the possibility of realizing effective energy exchange in unstable interpenetrating beams with sufficiently large currents. The relation between the observed oscillations and the velocity of the ion beams is also measured and a proportionality between these two quantities was found, attributed to the Doppler effect observed in a coordinate system connected with the stationary plasma. Orig. art. has: 6 figures and 3 formulas.

SUB CODE: 20/ SUBM DATE: 26Nov65/ ORIG REF: 005/ OTH REF: 001

Card 2/2

L 06310-67 EWT(l)/EWT(m)/EWP(t)/ETI IJP(c) AT/JD/JG/GD

ACC NR: AT6020434 (N) SOURCE CODE: UR/0000/65/000/000/0044/0051

AUTHOR: Gabovich, M. D.; Kirichenko, G. S.; Koydan, V. S.

ORG: none

72
B+1

TITLE: Interaction of ion beams with a plasma

SOURCE: AN UkrSSR. Vzaimodeystviye puchkov zaryazhennykh chastits s plazmoy (Interaction of charged particle beams with plasma). Kiev, Naukova dumka, 1965, 44-51

TOPIC TAGS: plasma beam interaction, ion beam, cesium plasma, inert gas, gas density, plasma electron temperature, standing wave

ABSTRACT: The experimental parameters were chosen to satisfy the instability criteria derived by Vedenov, et al (*UFN*, 1961, 73, 701) using a cesium ion beam with an energy of several ev. A plasma of 10^{10} cm^{-3} particle density was produced in inert gas discharges. Beam density was of the same order of magnitude. The amplitude and frequency of oscillations excited by ion beams was studied as a function of the electron temperature, gas density and ion mass. It is shown that the peak amplitude of the frequency spectrum can be explained by the theoretical ion beam energy at which stable operation occurs. As magnetic field was increased (in a direction parallel to the beam), there was a great increase in noise which made the diagnostic measurement more difficult. However, it was possible to show that the excited oscillations have the same

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L 06310-67

ACC NR: AT6020434

character as in the case where there is no magnetic field. In particular, the critical beam energy above which stable operation occurs was demonstrated through the use of a feedback scheme which generated a standing wave. The experimental results show that ion beams can be used for the plasma diagnostics since the critical energy depends strongly on the electron temperature of the plasma. Orig. art. has: 6 figures, 1 formula.

SUB CODE: 20/ SUBM DATE: 11Nov65/ ORIG REF: 007/ OTH REF: 004

Card 2/2 gd

GABOVICH, M.O.; TSVETSINSKIY, S.V.

Operation of rotary continuous diffusers. Sakh.prom.30 no.3:24-31 Mr '56. (MLRA 9:7)

1.Kurskiy sakhsveklotrest (for Gabovich).2.Sakharnyy zavod imeni Kuy'bysheva (for TSvetsinskiy).
(Sugar machinery)

GABOVICH, M.S.

Performance of rotary diffusers. Sakh. prom. 32 no.4:8-11 Ap '58.
(MIRA 11:6)

1. Upravleniye sakharnoy promyshlennosti Kurskogo sovnarkhoza.
(Diffusers)

GABOVICH, M.S.

Modernization of rotary diffusers. Sakh.prom. 32 no. 7:8-12 Jy '58. (MIRA 11:8)

1. Upravleniye sakharnoy promyshlennosti Kurskogo sovnarkhoza. (Diffusers)

GABOVICH, M.S.

Quality of brass tubes for the surfaces of heat-exchange apparatus. Sakh.prom. 32 no.11:33-34 N '58. (MIRA 11:12)

1.Upravleniye sakharnoy promyshlennosti Kurskogo sovnarkhoza.
(Heat exchangers) (Tubes, Copper)

GABOVICH, M. S.

Some defects of new diffusion batteries. Sakh. prom., 26, no. 3, 1952.

GABOVICH, M.S.

Increasing the capacity of heat exchangers. Sakh.prom. 27 no.8:34-35 Ag '53. (MLRA 6:8)

1. Kurskiy sakhsveklotrest. (Sugar machinery)

GABOVICH, M.S.

More attention to new equipment. Sakh.prom. 30 no.4:4-7 Ap '54.
(MLRA 9:8)

1. Kurskiy sakhsveklotrest.
(Sugar industry--Equipment and supplies)

GABOVICH, M.S.

Concerning M.A.Miagkov's article on material and technical supply. Sakh.prom. 29 no.1:5-6 '55. (MIRA 8:4)

1. Kurskiy sakhsveklotrest.
(Sugar industry--Equipment and supplies)

GABOVICH, M.S.

Greater attention to modernization of equipment. Sakh.prom. 31 no.3:6-8 Mr '57. (MIRA 10:4)

1. Kurskiy sakhsveklotrest.

(Sugar industry--Equipment and supplies)

GABOVICH, M.S.

Turning the pages of the plan of the State Food Industry Publishing House for Technology and Economics. Sakh. prom. 31 no.5:75 My '57. (MIRA 10:6)

(Sugar industry--Handbooks, manuals, etc.)

MOSKALENKO, S.I.; GABOVICH, M.S.; BACHINSKIY, Yu.V.; TOMILIN, A.V.; MEDVEDEV, P.M.; LOMANOVA, M.M.; GOLOVKOV, P.D.; GAYDUKOV, G.I.; ALEYNIKOV, V.V.; STENIN, N.D.; MIRONOVA, V.V.; BELAVINTSEVA, Ye.S.; TSVETSINSKIY, S.V.; NECHKPURNYY, P.; KOBZAR', N.K.; ROZHNOVA, Ye.S.; PRLETMINSKIY, V.N.; GORDEYCHUK, V.K.; SHMERIGO, V.F.; KISLYUK, N.

Fifty years in the sugar industry. Sakh.prom. 33 no.2:18 F '59. (MIRA 12:3)

(Shtepan, Georgii Viacheslavovich, 1888-)

GABOVICH, M.S., PRILUTSKIY, I.I.

Characteristics of the screw conveying system in battery diffusion cells. Sakh.prom. 34 no.7:28-30 Jl '60. (MIRA 13:7)

1. Kurskiy sovnarkhoz (for Gabovich) 2. TSentral'nyy nauchno-issledovatel'skiy institut sakharnoy promyshlennosti (for Prilutskiy).
(Kshen (Kursk Province)—Sugar manufacture)

GABOVICH, R. D.

Purification of water under field conditions Moskva, Medgiz, 1939. 154 p.

PROCESSES AND PROPERTIES INDEX

Ca

14

Removal of poisons from water in the water supply of troops. R. D. Gabovich. *Vodosnabzhenie Sanit. Tekh.* 14, No. 9, 92-101(1939); *Chem. Zentr.* 1940, I, 1513.—Review of methods for testing water quality and for the removal of yperite, As compds., unstable war chemicals, HCN and cyanides, salts of heavy metals, and alkaloids from water to be used for drinking purposes.

H. E. Wirth

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

GABOVICH, R. D.

Gabovich, R. D. "Fluorine in the drinking water of the Ukraine and its hygienic significance" (Summary of the paper), Soobshch. o nauch. rabotakh chlenov Vsesoyuz. khim. o-va im. Mendeleyeva, 1948, Issue 3, pp. 9-10.

SO: U-3261, 10 April 53 (Letopis 'Zhurnal 'nykh Statey No.11, 1949)

CA 14

Chlorination of well water. R. D. Gabovich. *Gigiena i Sanit.* 13, No. 6, 10-16(1948).—Chlorination of water in wells is permissible only in exceptional cases and must be used under conditions of superchlorination with residual Cl being not under 0.5-0.6 mg./l. Usually 15-20 mg./l. charge should be used (equiv. to 75-100 mg./l. of $Ca(ClO_4)_2$). The drawn water is passed through activated C (most simply contained in a barrel) before consumption.

G. M. Kosolapoff

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

GABOVICH, R. D.

"Chlorination of Well Water," Gig. i San., No.6, 1949

Chair Gen. Hygiene, Kiev Med. Int.

GABOVICH, DOCENT R. D.

USSR/Medicine - Water, Supply Jul 49
Medicine - Water Purification

"The Fluorine Content in Drinking Water in the Ukrainian SSR," Docent R. D. Gabovich, Chair of Gen Hygiene Kiev Med Inst, 5½ pp

"Gig i San" No 7

Fluorine content in Ukrainian water sources varies from a mere trace to over one mg/l. Mass inspection of drinking water has already made it possible to study the relation between fluorine concentration and pitted enamel and caries in teeth in addition to other ailments. This work should be promoted by hygienists.

62/49T66

GABOVICH, R. D.

"Impurity Level in the Problem of Sanitary Protection of Water Reservoirs," Gig. i San., No.12, 1949.